

InSitu PreEpi Clean Process for Next Generation Devices

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Introduction

With further reduction of the dimensions of the microelectronic devices into the low nm scale, the cleaning procedures play an increasingly important role in the IC manufacturing. The process chemicals, sequence and number of cleaning steps are becoming more critical in determining the desired end results.

In the present study, different pre-epitaxial cleaning processes were investigated. Conventional multi tank HF-last process was compared to one step insitu HF-last process. Results showed that dilute chemicals and insitu HF/Drying are key factors to successful wafer processing for IC manufacturing.

Experimental

Experiments were conducted on Akrion’s GAMA-1™ automated wet station. The tool is capable of running two process sequences; multi-tank and single tank insitu process. Wafers were processed in the tool prior to the epitaxial growth steps. To simulate patterned wafers situations, silicon wafers were sandwiched between the dummy oxide wafers. That provided the most challenging contamination to the silicon wafers from the oxide wafers. Etch byproducts were deposited from the oxide wafers onto the bare silicon wafers. Different cleaning techniques were used to remove this high contamination level. Conventional sequence of SC1Rinse//HF/Rinse/Dry was used first to remove the contaminants. Surfactant was mixed with HF as part of the process development. A modified insitu cleaning sequence was developed for minimum particle deposition.

Results and Discussion

Results showed that conventional HF-last process (SC1/Rinse/HF/Rinse/Dry) resulted in high particle counts at 0.12 μm (>10,000). Consequently, the post epitaxial defects were also high (>30,000). These LPDs (light point defects) are considered to be the poly nucleation sites during the epitaxial deposition. Conventional wafer transfer between tanks played a significant role of increasing the silicate deposition onto bare silicon wafers. As shown in figure 1, particle addition was in the thousands range. Surfactant was added to the HF bath as a way to improve the wettability of wafers and hence reducing the particle deposition onto the wafers. Better process results were obtained compared to conventional. However, the presence of the surfactant remained a challenge to the epitaxial growth process. Additional processing (e.g. ozone chemistry) would have to be needed to remove any trace amounts of the surfactant. On the other hand, if wafers are processed insitu with no transfer between critical steps, much less particle deposition can be obtained. As shown in figure 2, an average of less than 50 particles (@ ≥ 0.12 μm) were added to the wafers through an insitu HF-last process. Results also showed that the amount of [O] present on the wafer surface could significantly increase the poly defects nucleated on the wafer surface. The lower the [O] content on a well H-passivated surface the lower the post-epi defect counts obtained.

Conclusions

A modified insitu cleaning procedure was developed for pre epitaxial growth. Results showed significant improvement was obtained when compared to conventional HF-last cleaning process. The insitu processing (one step etch/rinse/dry) has shown to be a key factor in elimination of particle deposition on exposed silicon areas on the wafer surface.

References

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Figure 1: Particle signature for a conventional HF-last process 0.12 μm.

Figure 2: Particle signature for an insitu HF-last process at 0.12 μm

